Overview of Hyperspectral Environment Suite (HES) Tasks

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Outline

- **HES Background**
- **HES Tasks**
- **HES Tasks Requirements**

Background

- **The Hyperspectral Environmental Suite (HES) is located on a geostationary platform, specifically the B satellite, and comprises one or multiple instruments procured under one contract.**
  - **Government has no preferred configuration of tasks at this time**

- **HES is an outgrowth of earlier ABS efforts**
  - **HES includes the functionality of the old Advanced Baseline Sounder (ABS) while affording better severe weather/Mesoscale coverage**
    - **Finer spatial resolution**
  - **HES has been expanded to include other capabilities for environmental monitoring employing the improved temporal resolution from GEO.**
    - **Coastal Ocean**
    - **Open Ocean**
    - **Land**

HES Tasks

- HES - Disk Sounding (HES-DS)
  - Formerly ABS, but government has no preference for instrument type
  - Threshold Task
- HES - Severe Weather / Mesoscale (HES-SW/M)
  - Threshold Task
- HES - Coastal Waters (HES-CW)
  - Threshold Task
- HES - Ocean Waters (HES-OO)
  - Goal Task
- HES - Land (HES-L)
  - Goal Task

HES-Disk Sounding (HES-DS) task

- **Spatial Resolution**
  - **IR: Threshold=10 km, Goal=2 km, Vis: Threshold=1.0 km, Goal= 0.5 km**
- **Coverage rate (Threshold)**
  - **62 degree LZA / hour or 245 Hz (TBR) Ground Sample Rate (GSR) at 10 km resolution**

    Meeting GSR provides nominally constant noise performance

    $GSR = R_{cov} / (A_{pix} * \varepsilon_{scan})$

    where R_{cov} = coverage rate (R_{cov} = 2.0e4 km^2/sec)

    A_{pix} = product pixel area

    ε_{scan} = scan efficiency (includes overlap to avoid gaps, image rotation, number of needed calibrations, and scan mirror step and settle)

    Coverage area must be flexible and selectable.

HES-Disk Sounding (HES-DS) task (cont'd)

- **Spectral Coverage**
  - **Three specific examples of coverage are given in MRD**

    Update of MRD (MRD-IA) will include Abstracted listing of spectral coverage (and NEdNs), which reflect these examples

    General text about the spectral information is also supplied
  - **Essentially: 15 um CO_2 band for temperature, clear windows from 13 um and extending past the ozone band at 9.6 um to 8.3 um, and either side of the 6 um H_2O band. More temperature: Coverage of 4.7 um to 4.4 um and goal coverage of 4.7 um to 3.7 um. Visible: 0.52-0.7 um**

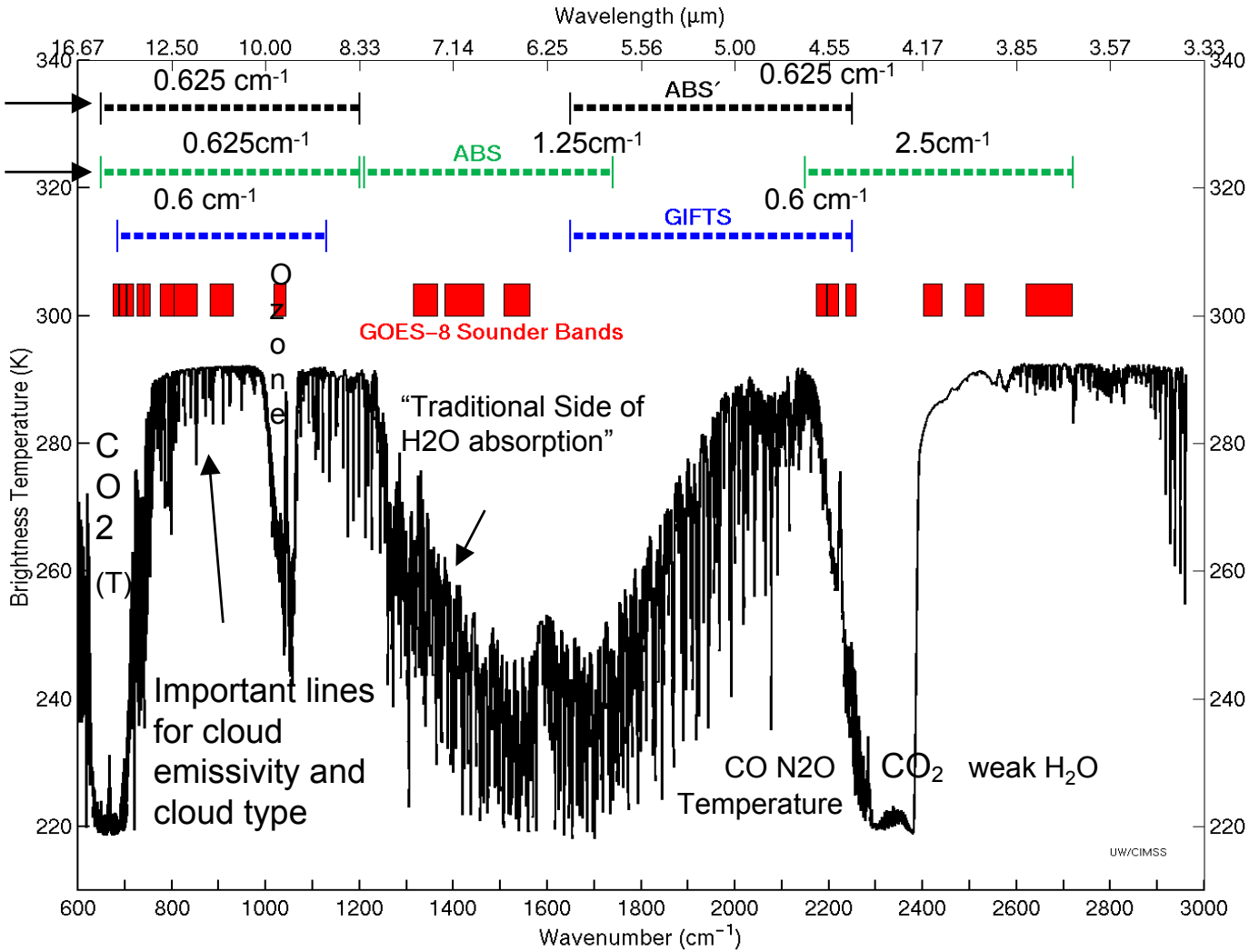
- **Spectral resolution:**
  - **15 um CO_2 band: 0.6 cm^{-1}, Windows: 0.6-1.0 cm^{-1}, Ozone: 1 cm^{-1}, H_2O: 1-2 cm^{-1}, near 4 um: 2.5 cm-1, Visible: 0.18 um**

IR Spectral Coverage (DS or SW/M)

Example 1

Example 2

(Example 3 not shown)



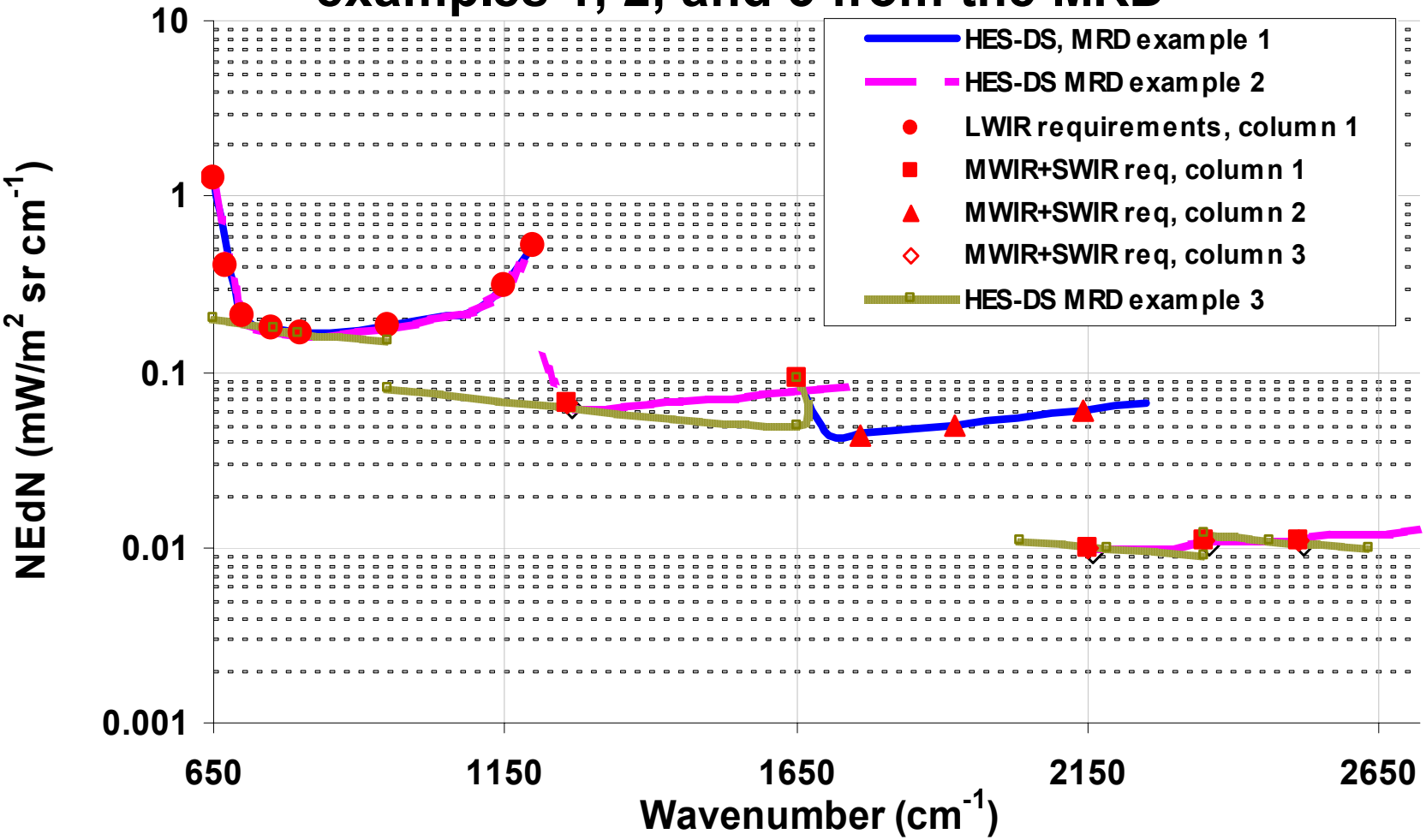
Plot courtesy of Tim Schmit

Abstracted list of NEDN points

Wavenumber (cm^{-1})	Resolution element	NEDN (mW/m^2 sr cm^{-1})	NEdT at 250 K(K)
650	0.625	< / = 1.265	< / = 1.036
670	0.625	< / = 0.40	< / = 0.31
700	0.625	< / = 0.212	< / = 0.175
750	0.625	< / = 0.176	< / = 0.147
800	0.625	< / =0.166	< / = 0.146
950	0.625 or <0.75	< / = 0.182 or <0.17	< / = 0.191 or <0.18
1150	0.625 or <0.90	< / = 0.310 or <0.26	< / = 0.483 or <0.40
1200	0.625 or <0.94	< / = 0.529 or <0.43	< / = 0.918 (goal) or <0.75
1258 or 1923 or 1258	1.25 or 0.625 or 1.25	≤ 0.066 or ≤ 0.050 or ≤ 0.066	≤ 0.135 or ≤0.853 or < 0.135
1650 or 1644 or 1650	1.25 or 0.625 or 1.25	≤ 0.092 or ≤ 0.077 or < 0.092 (using 0.05 for the third column meets all point across the band, as shown in Fig. 4)	≤ 0.605 or ≤ 0.504 or < 0.605 (using 0.33 for the third column meets all points across the band, shown Fig.4)
2150 or 2141 or 2150	2.50 or 0.625 or 2.50	≤ 0.01 or ≤ 0.061or < 0.01	≤ 0.416 or ≤ 2.383 or < 0.416
2350 or xx or 2350	2.50 or xx or < 2.50	≤ 0.011 or xx or < 0.01	≤ 0.966 or xx or < 0.966
2513 or xx or 2513	2.50 or xx or < 2.50	≤ 0.011 or xx or < 0.011	≤ 1.981 or xx or < 1.981

HES-DS Noise (Abstracted NEDN points)

NEdNs for HES-DS when using examples 1, 2, and 3 from the MRD



HES-Severe Weather/Mesoscale (HES-SW/M) task

- **Spatial Resolution**
  - IR: Threshold=4 km, Goal=2 km, Vis: Threshold=1.0 km, Goal= 0.5 km
- **Coverage rate**
  - 1000 km x 1000 km (locations vary) in 4.4 minutes (or 245 Hz).

    Now using the same ground sample rate as the HES-DS, which leads to appropriate noise performance

    Threshold implication is that the tasks are *not* required concurrently (62 degree LZA and $(1000km)^2$ are *not* both required in one hour.
  - Coverage area must be flexible and selectable.
- **Spectral coverage:**
  - Specific examples are cited in the MRD
  - Essentially: 15 um CO_2 band for temperature, clear windows from 13 um and extending past the ozone band at 9.6 um to 8.3 um, and either side of the 6 um H_2O band. More temperature: Coverage of 4.7 um to 4.4 um and goal coverage of 4.7 um to 3.7 um. Visible: 0.52-0.7 um
- **Spectral resolution:**
  - 15 um CO_2 band: 0.6 cm^{-1}, Windows: 0.6-1.0 cm^{-1}, Ozone: 1 cm^{-1}, H_2O: 1-2 cm^{-1}, near 4 um: 2.5 cm^{-1}, Visible: 0.18 um

HES-Coastal Waters (HES-CW) task

- **Spatial Resolution**
  - Reflected solar < 1.0 um: Threshold=0.3 km, Goal =0.15 km
  - Reflected solar > 1.0 um: Threshold=1.2 km (TBR), Goal =0.9 km (TBR)
  - (Goal LWIR is 2.0 km (Threshold), 1.0 km (Goal))
- **Coverage rate**
  - Coastal coverage along length of coast (Longest: US east and gulf coast: ~6000 km by ~400 km in width (totaling ~ 2.4e6 km^2) in 1 hour (TBR)
  - Coverage area must be flexible and selectable.
- **Spectral coverage:**
  - <u>selected bands from 0.4 to 1.0 um (Threshold)</u>
  - all bands from 0.4 to 2.285 um (Goal) and 11.2 um, 12.2 um (Goal)
- **Spectral resolution:**
  - 0.02 um (Threshold)
  - 0.02 um and 0.8, 1.0 um (Goal)

HES-CW Task Band Descriptions

Table 4d. CW Task Band Descriptions (Thresholds and Goals)

Wavelength (um)	Bin size (um)	Number of bins
0.40 –2.285 um and 11.2, 12.3 um or all of the bands listed below (GOAL)	0.02, 0.8, 1.0	97
0.412 (THRESHOLD)	0.02	1
0.443 (THRESHOLD)	0.02	1
0.477 (THRESHOLD)	0.02	1
0.490 (THRESHOLD)	0.02	1
0.510 (THRESHOLD)	0.02	1
0.530 (THRESHOLD)	0.02	1
0.550 (THRESHOLD)	0.02	1
0.645 (THRESHOLD)	0.02	1
0.667 (THRESHOLD)	0.02	1
0.678 (THRESHOLD)	0.02	1
0.750 (THRESHOLD)	0.02	1
0.763 (THRESHOLD)	0.02	1
0.865 (THRESHOLD)	0.04	1
0.905 (THRESHOLD)	0.02	1
1.38 (GOAL)	0.03	1
1.61 (GOAL)	0.06	1
2.26 (GOAL)	0.05	1
11.2 (GOAL)	0.8	1
12.3 (GOAL)	1.0	1

HES-Open Ocean (HES-OO) task

- **Spatial Resolution**
  - **Reflected solar: Threshold=4.0 km, Goal =1.0 km**
- **Coverage rate:**
  - **Open ocean area lying within the 62 degree LZA in 3 hours (~6 e7 km^2 GOES West oceans) (TBR)**
  - **Coverage area must be flexible and selectable.**
- **Spectral coverage: selected bands between 0.4 and 1.1 um**
- **Spectral resolution: 0.02 um**

HES-OO Task Band Descriptions

Table 4c. OO Task Band Descriptions (Thresholds and Goals)

Wavelength (um)	Bin size (um)	Number of bins
0.4 –1.1 um or all of the bands listed below (GOAL)	0.02	35
0.412	0.02	1
0.443 (THRESHOLD)	0.02	1
0.477 (GOAL)	0.02	1
0.490 (THRESHOLD)	0.02	1
0.510 (GOAL)	0.02	1
0.530 (THRESHOLD)	0.02	1
0.550 (THRESHOLD)	0.02	1
0.645 (THRESHOLD)	0.02	1
0.667 (THRESHOLD)	0.02	1
0.678 (GOAL)	0.02	1
0.750 (GOAL)	0.02	1
0.763 (GOAL)	0.02	1
0.865 (THRESHOLD)	0.04	1
0.905 (GOAL)	0.02	1

HES-Land (HES-L) task

- **Spatial Resolution**
  - **Reflected solar: Threshold=2.0 km, Goal =0.5 km**
- **Coverage rate**
  - **Land within 62 degree LZA (~4.4e7 km^2) in TBD hours.**
  - **Coverage area must be flexible and selectable.**
- **Spectral coverage:**
  - **1.6 um, 2.26 um (Threshold)**
  - **0.64 um, 0.86 um (TBR), 1.61 um, 2.26 um (Goal) or all 0.59-2.285 um (Goal)**
- **Spectral resolution:**
  - **0.06, 0.05 (Threshold)**
  - **0.1um, 0.04, 0.06um, 0.05um (Goal) or all ~0.01 um (TBR)**

HES-L Task Band Descriptions

Table 4e. L Task Band Descriptions (Thresholds and Goals)

Wavelength (um)	Bin size (um)	Number of bins
0.59 – 2.285 um or all of the bands listed below (GOAL)	~0.01(TBR)	170
0.64 (GOAL)	0.1	1
0.86 (TBR) (GOAL)	0.04	1
1.61 (GOAL)	0.06	1
2.26 (GOAL)	0.05	1

Connecting HES Tasks

- These HES tasks do not have to be done with only one instrument.
  - Constraints on overall mass, power, and volume must be met however.
- Subsequent talks on the individual tasks do not necessarily represent an optimum combination of the HES task.
  - Talk on Point Designs for the ABS (now the HES-DS task)

    Reflect pre-history of HES

    Shows two possible solutions for this task (details on CD in ~2 weeks)
  - Talk on Meeting the SW/M task

    Concepts for HES-SW/M as one instrument or two.
  - Talk on the CW task

    Outgrowth concept from 2 pre-HES point designs